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## Question #1

**Q1# in digital communication system why do we carry out modulation? Also, explain frequency division multiplexing as well as time division multiplexing are any other multiplexing techniques to increased data rate**

### **Definition Modulation:**

Modulation in communication is the process where one of the properties of the periodic signal (the carrier wave) like amplitude, phase or the frequency is altered according to the message signal (Baseband signal).

### **The reason of carrying out Modulation:**

#### **i) To separate signal from different transmitters:**

Audio frequencies are within the range of 20 Hz to 20 kHz. Without modulation, all signals at same frequencies from different transmitters would be mixed up. There by giving impossible situation to tune to any one of them. In order to separate the various signals, radio stations must broadcast at different frequencies.

#### **ii) Size of the antenna:**

For efficient transmission, the transmitting antennas should have length at least equal to a quarter of the wavelength of the signal to be transmitted. For an electromagnetic wave of frequency 15 kHz, the wavelength  $\lambda$  is 20 km and one-quarter of this will be equal to 5 km. obviously, a vertical antenna of this size is impartible. On the other hand, for a frequency of 1 MHz, this height is reduced to 75 m.

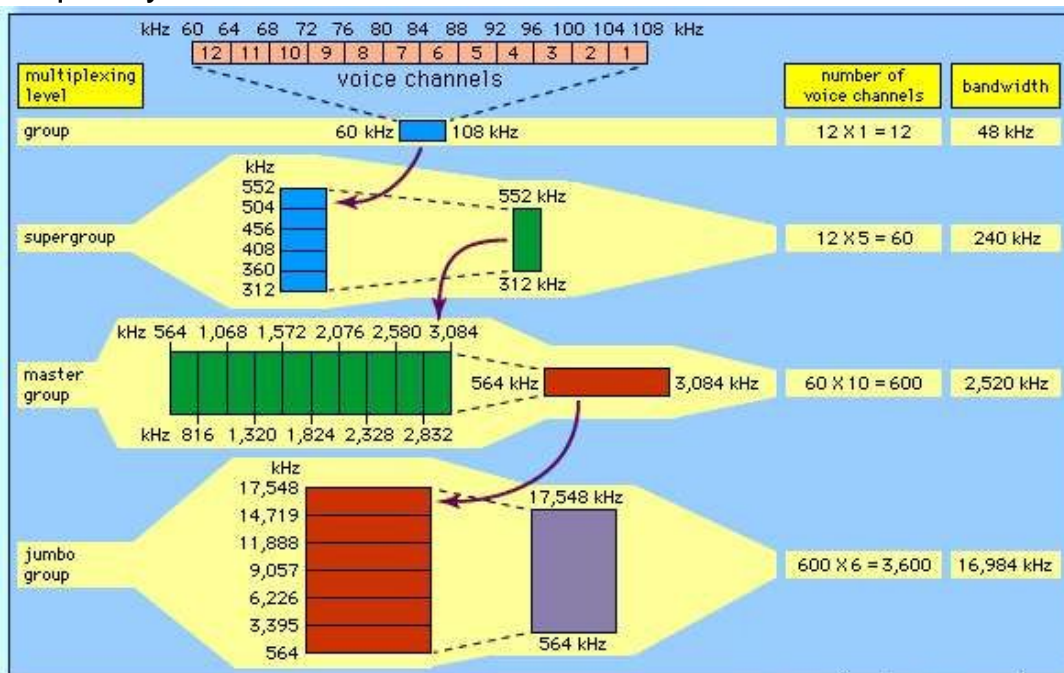
#### **iii) To Reduce Antenna Height. (Practicability of antennas height).**

#### **iv) Transmit the Information To long Distance Without interference.**

#### **v) Reduce bandwidth.**

## Frequency-division multiplexing:

In frequency-division multiplexing (FDM), the available bandwidth of a communications channel is shared among multiple users by frequency translating, or modulating, each of the individual users onto a different carrier frequency. Assuming sufficient frequency separation of the carrier frequencies that the modulated signals do not overlap, recovery of each of the FDM signals is possible at the receiving end. In order to prevent overlap of the signals and to simplify filtering, each of the modulated signals is separated by a guard band, which consists of an unused portion of the available frequency spectrum. Each user is assigned a given frequency band for all time.

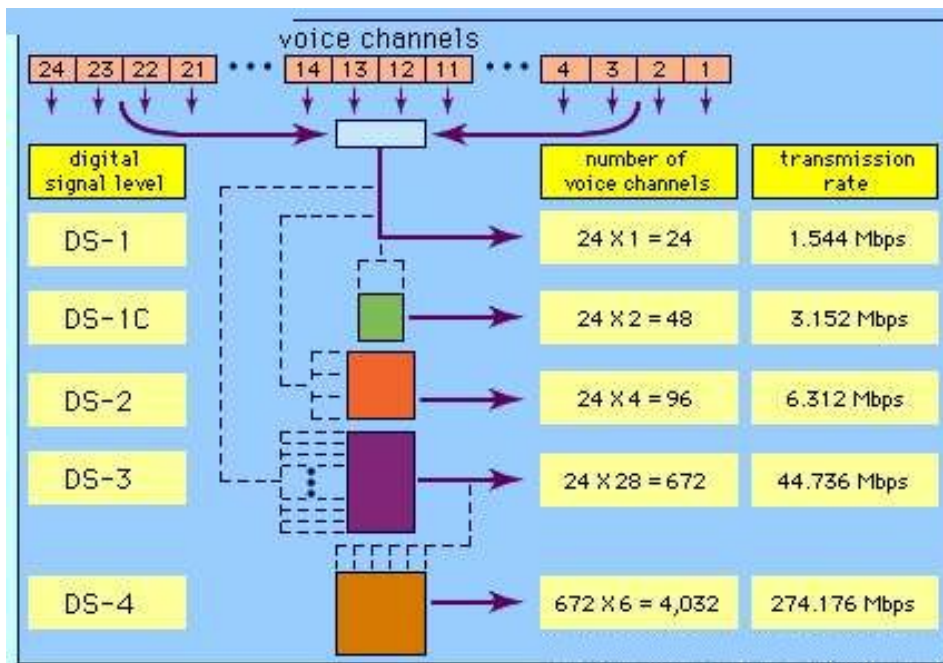


While each user's information signal may be either analog or digital, the combined FDM signal is inherently an analog waveform. Therefore, an FDM signal must be transmitted over an analog channel. Examples of FDM are found in some of the old long-distance telephone transmission systems, including the American N- and L-carrier coaxial cable systems and analog point-to-point microwave systems. In the L-carrier system, a hierarchical combining structure is employed in which 12 voice band signals are frequency-division multiplexed to form a group signal in the

frequency range of 60 to 108 kilohertz. Five group signals are multiplexed to form a super group signal in the frequency range of 312 to 552 kilohertz, corresponding to 60 voice band signals, and 10 super group signals are multiplexed to form a master group signal. In the L1 carrier system, deployed in the 1940s, the master group was transmitted directly over coaxial cable. For microwave systems, it was frequency modulated onto a microwave carrier frequency for point-to-point transmission. In the L4 system, developed in the 1960s, six master groups were combined to form a jumbo group signal of 3,600 voice band signals.

### Time-division multiplexing:

Multiplexing also may be conducted through the interleaving of time segments from different signals onto a single transmission path—a process known as time-division multiplexing (TDM). Time-division multiplexing of multiple signals is possible only when the available data rate of the channel exceeds the data rate of the total number of users. While TDM may be applied to either digital or analog signals, in practice it is applied almost always to digital signals. The resulting composite signal is thus also a digital signal.



In a representative TDM system, data from multiple users are presented to a time-division multiplexer. A scanning switch then selects data from each of the users in sequence to form a composite TDM signal consisting of the

interleaved data signals. Each user's data path is assumed time-aligned or synchronized to each of the other users' data paths and to the scanning mechanism. If only one bit were selected from each of the data sources, then the scanning mechanism would select the value of the arriving bit from each of the multiple data sources. In practice, however, the scanning mechanism usually selects a slot of data consisting of multiple bits of each user's data; the scanner switch is then advanced to the next user to select another slot, and so on. Each user is assigned a given time slot for all time.

### **Multiple Access:**

Multiplexing is defined as the sharing of a communications channel through local combining at a common point. In many cases, however, the communications channel must be efficiently shared among many users that are geographically distributed and that sporadically attempt to communicate at random points in time. Three schemes have been devised for efficient sharing of a single channel under these conditions; they are called frequency-division multiple access (FDMA), time-division multiple access (TDMA), and code-division multiple access (CDMA). These techniques can be used alone or together in telephone systems, and they are well illustrated by the most advanced mobile cellular systems.

## **Question #1(B)**

**Q1 (B) # explain attenuation effect electromagnetic waves received power as a function of frequency**

### **Definition:**

Attenuation is the loss of signal strength in networking cables or connections. This typically is measured in decibels (dB) or voltage and can occur due to a variety of factors. It may cause signals to become distorted or indiscernible.

Attenuation is the reduction in amplitude and intensity of a signal. Signals may be attenuated exponentially by transmission through a medium, in which case attenuation is usually reported in dB with respect to distance traveled through the medium. Attenuation can also be understood to be the opposite of amplification. Attenuation is an important property in telecommunications and ultrasound applications because of its importance in determining signal strength as a function of distance. Attenuation is

usually measured in units of decibels per unit length of medium (dB/cm, dB/km, etc.) and is represented by the attenuation coefficient of the medium in question.

### **Attenuation effects on Electromagnetic waves:**

Attenuation decreases the intensity of electromagnetic radiation due to absorption or scattering of photons. Attenuation does not include the decrease in intensity due to inverse-square law geometric spreading. Therefore, calculation of the total change in intensity involves both the inverse-square law and an estimation of attenuation over the path. The primary causes of attenuation in matter are the photoelectric effect, Compton scattering and, for photon energies of above 1.022MeV, pair production.

$$\text{Attenuation (dB/100m)} = 10 \times \log_{10} \left( \frac{P_1 (W)}{P_2 (W)} \right),$$